Coastal Hazard Mapping and Monitoring in Western Alaska

Presented as part of the Lunch & Learn Seminar Series
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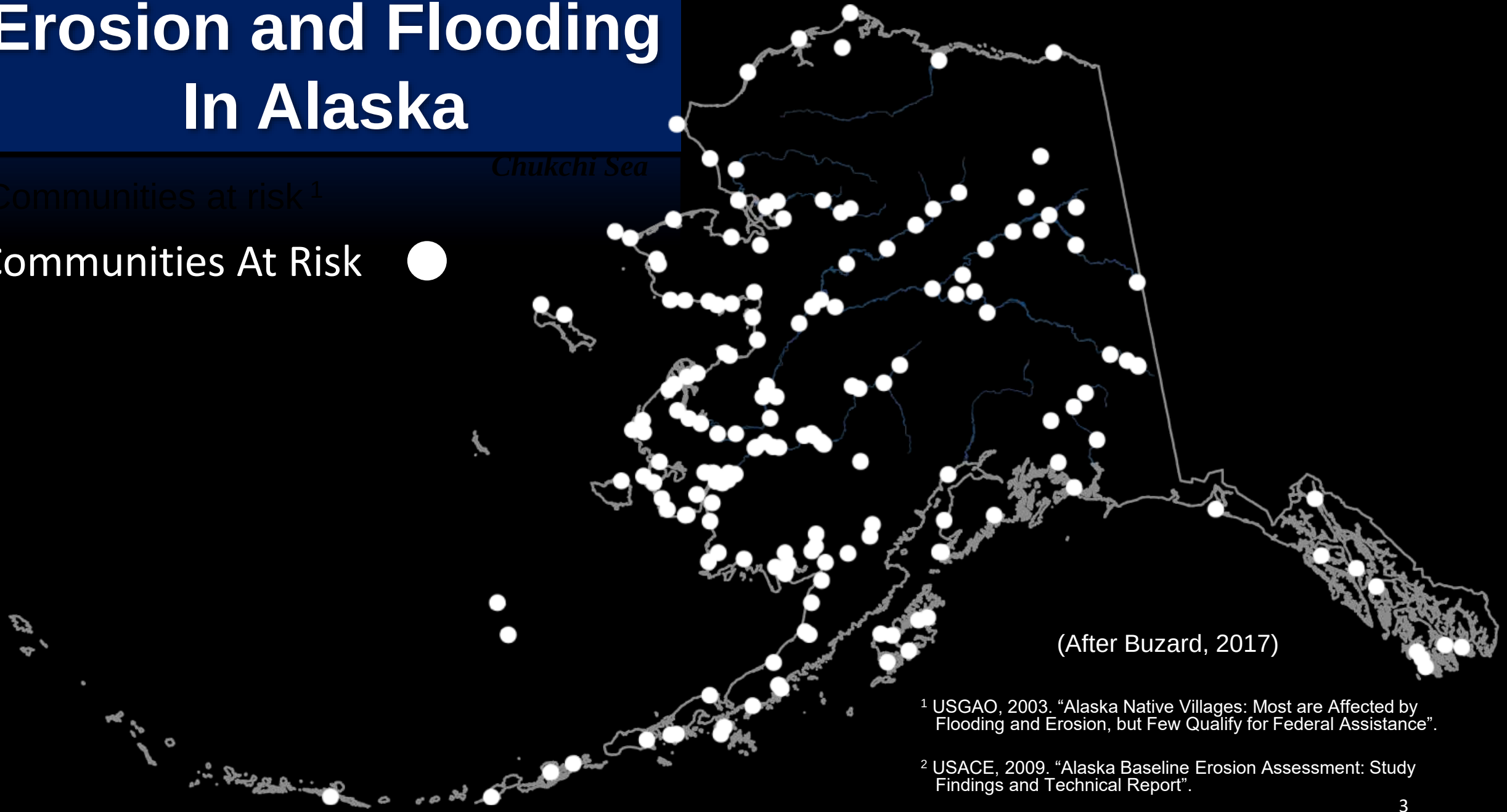
Erosion and Flooding In Alaska

Communities at risk [1]

Chukchi Sea

Communities At Risk

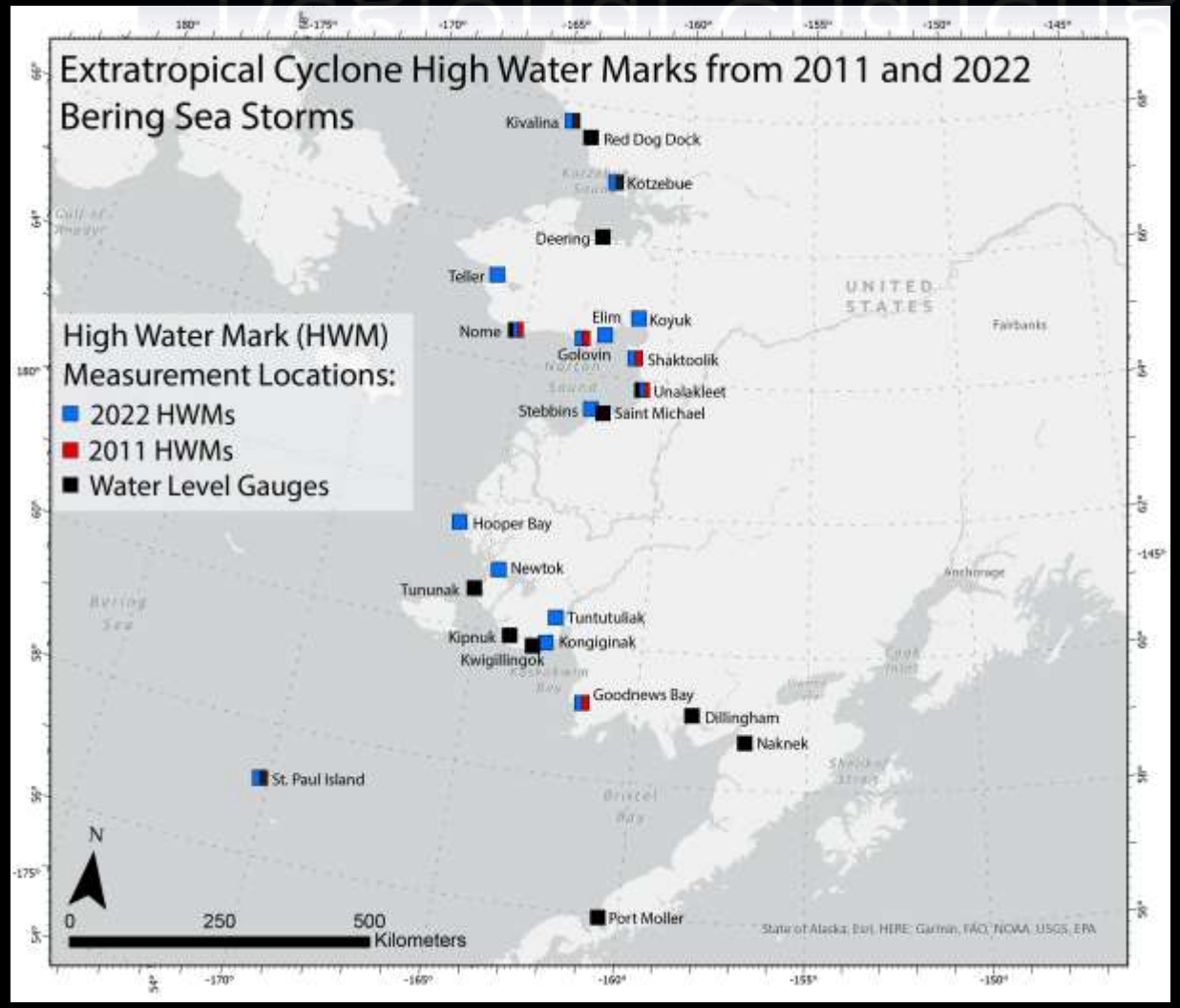


(After Buzard, 2017)

[1] USGAO, 2003. “Alaska Native Villages: Most are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance”.

[2] USACE, 2009. “Alaska Baseline Erosion Assessment: Study Findings and Technical Report”.

Regional Challenge: Instrumentation



SITE	2011 HWM	2022 HWM	2011 GAUGE MEASUREMENT	2022 GAUGE MEASUREMENT
NOME	6.2	5.4	2.8	2.8
ST. PAUL ISLAND		2.7	0.4	0.9
RED DOG DOCK			1.4	1.3
PORT MOLLER			1.3	0.4
UNALAKLEET	5.7	5.1		3.6
KOTZEBUE		1.9		1.3
KIVALINA		3.2		1.5
GOLOVIN	4.8	4.1		
SHAKTOOLIK	7.2	7.0		
GOODNEWS BAY	3.6	1.7		
DEERING		1.0		
TELLER		2.3		
ELIM		5.5		
KOYUK		5.5		
STEBBINS		3.7		
HOOPER BAY		3.5		
NEWTOK		1.8		
TUNUNAK		0.7		
KIPNUK		0.9		
KWIGILLINGOK		0.5		
KONGIGINAK		0.6		
TUNTUTULIAK		0.8		
DILLINGHAM		1.0		
NAKNEK		0.5		

Arctic Coastal Geoscience Lab (ACGL)

Contributing to tackling problems at the intersection of natural and human systems

1. Build long-term sustainable relationships with rural coastal communities
2. Advance science in regards to coastal hazard and provide data products to decision-makers
3. Increase training and education opportunities for students working in rural Alaska

Stakes for Stakeholders

Community Based Monitoring & Hazard Analysis

Goal: Partner with communities to measure, map and identify coastal hazards and provide data products for decision-making

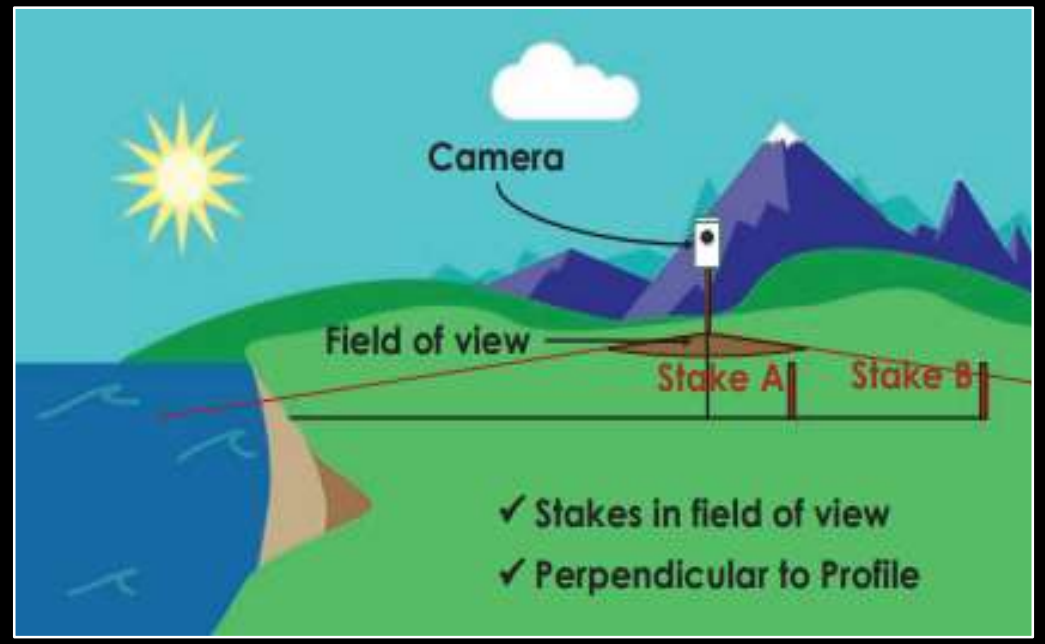
Student Driven Research

Buzard, Letzring, Glenn, Bogardus, Christian, Baldwin, Datson

GEOSCIENCE - SUSTAINABILITY - GEOSPATIAL SCIENCE

What we do

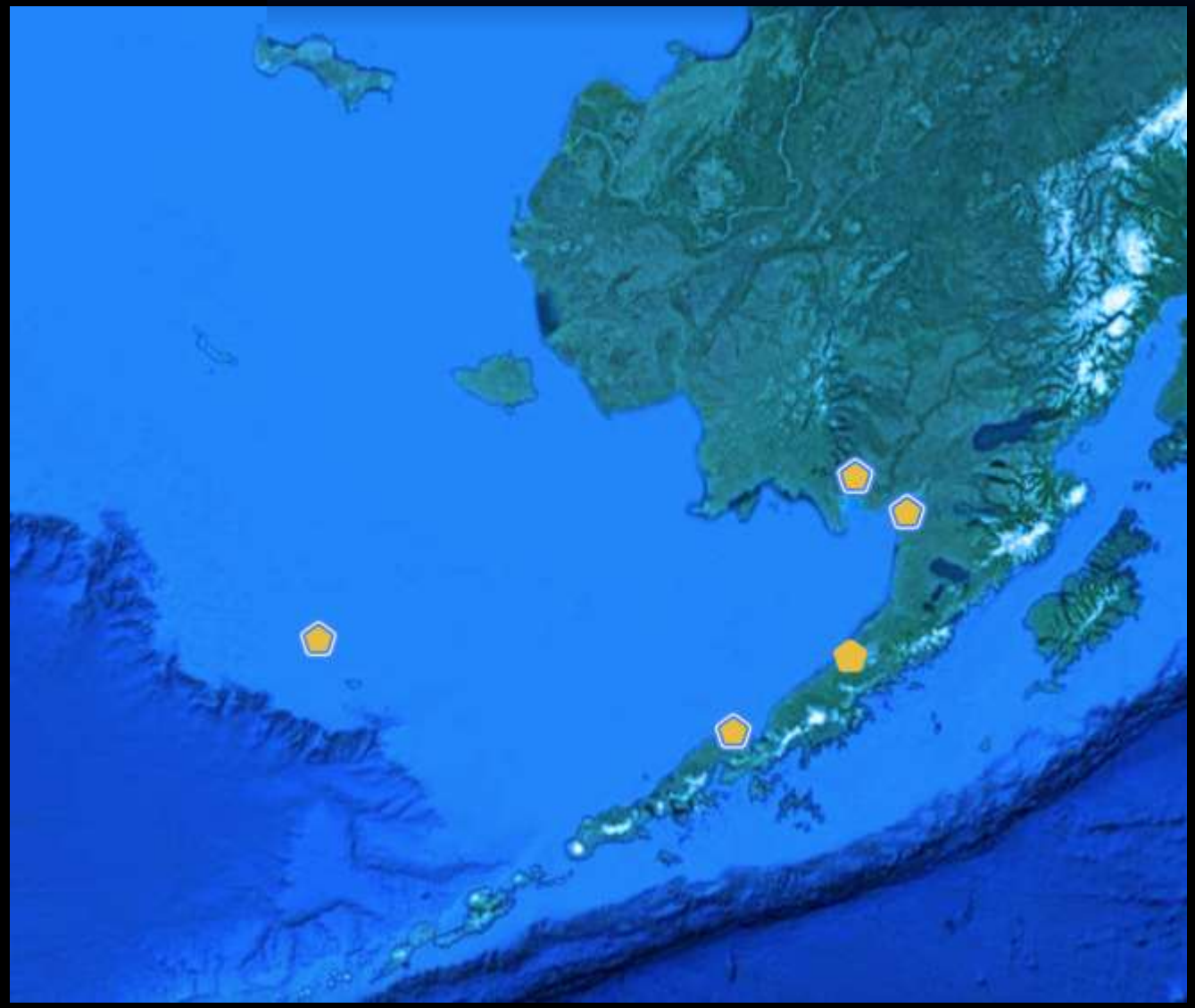
- Establish monitoring sites based on local and Indigenous Knowledge
- Collect baseline topographic and geospatial datasets
- Repeat surveys annually
- Co-produce data products



Community Partners

Chevak
Kongiginak
Mekoryak
Goodnews Bay
Togiak
Twin Hills
Dillingham
Ekuk
Levelock
Naknek
Pilot Point
Port Heiden
Nelson Lagoon
St. Paul
Chignik Bay
Ivanof Bay
Chignik Lagoon
Unalaska
Atka

Wave Buoy Deployments



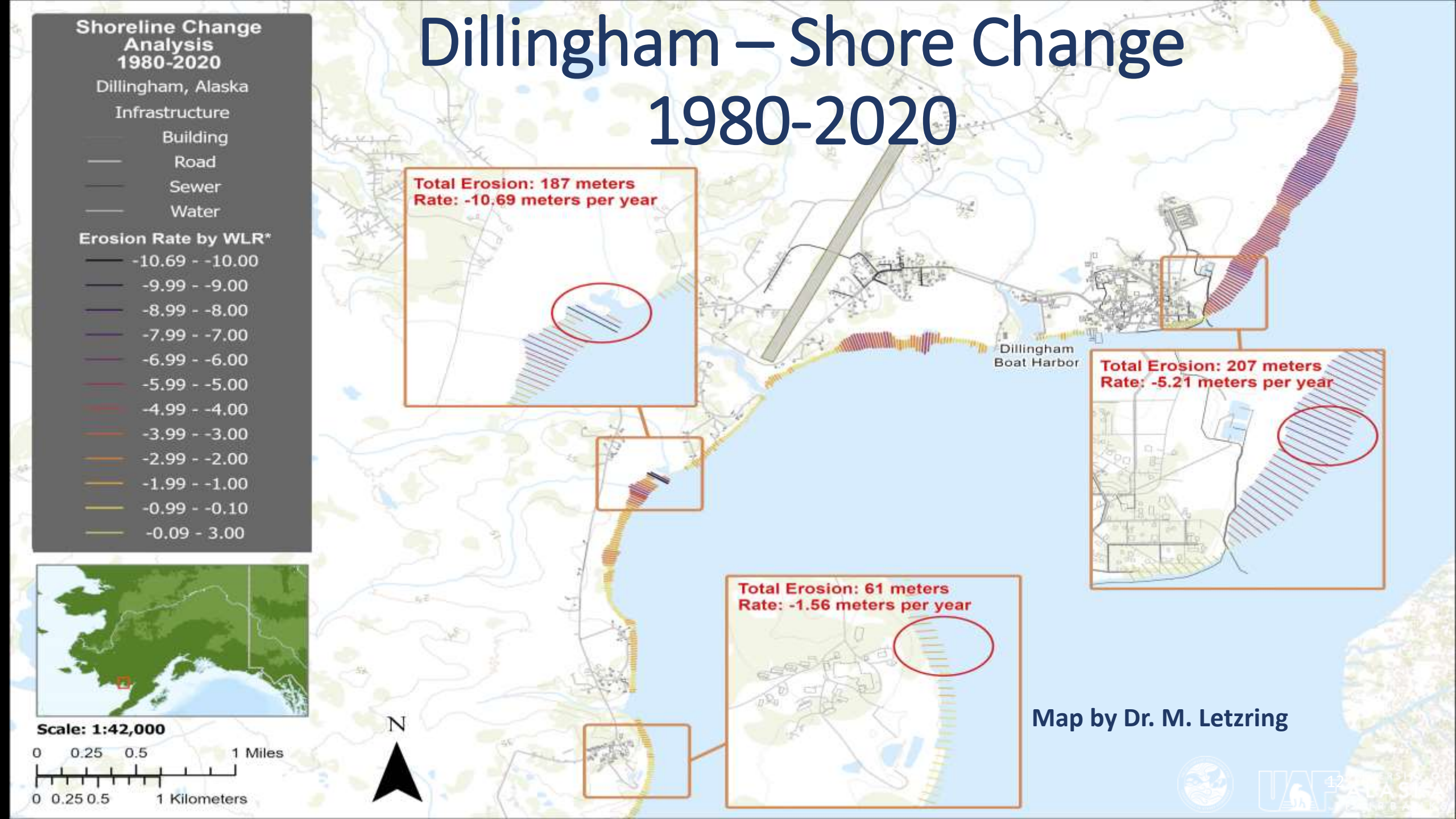
- Map of all ACGL wave buoy deployments
- St. Paul is only active wave buoy
- All data available in real-time to residents

https://spotters.sofarocean.com/?spotter-filter=SPOT-30004R

Dillingham


ALASKA
Bering Strait
Yukon-Kuskokwim Delta
South-central
Bristol Bay
Gulf of Alaska

Dillingham – Shore Change 1980-2020



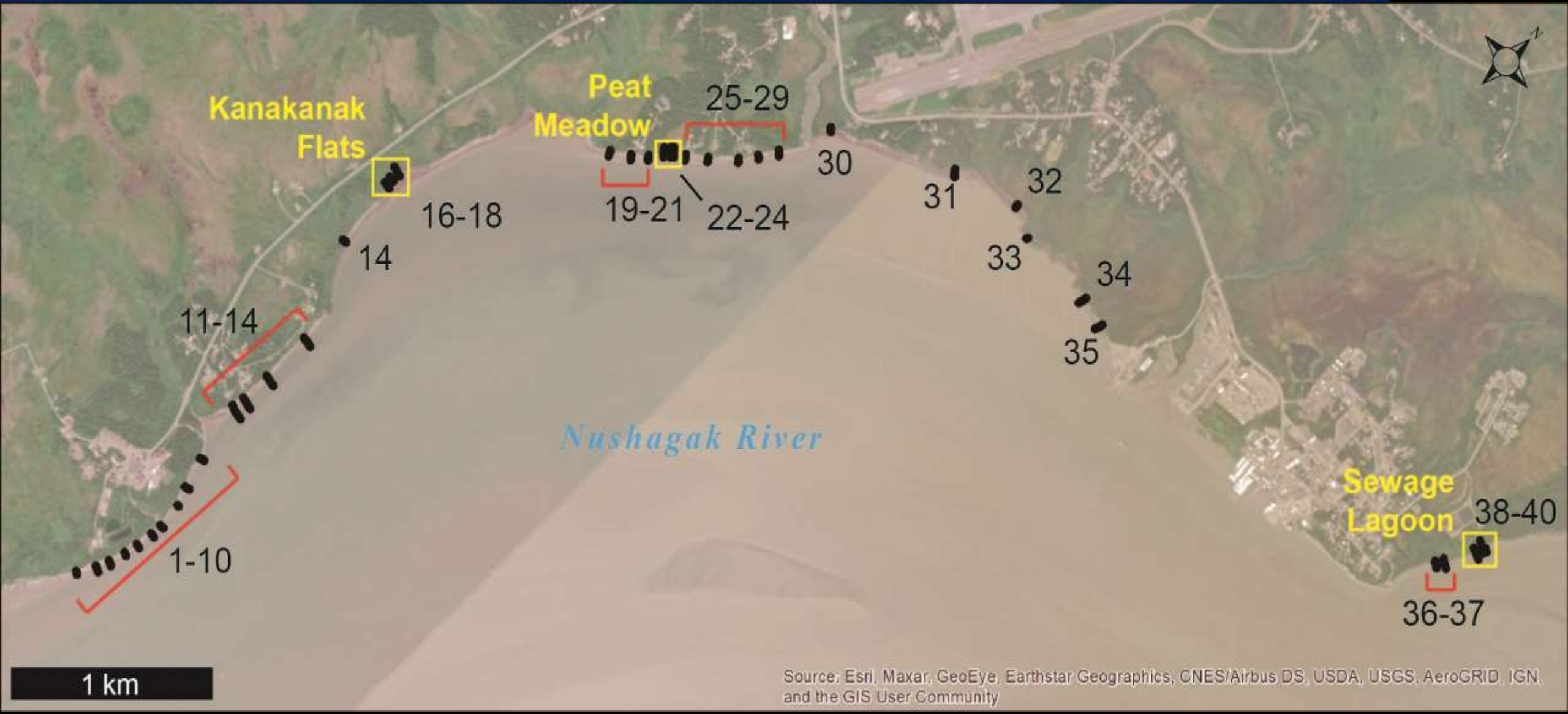
Map by Dr. M. Letzring

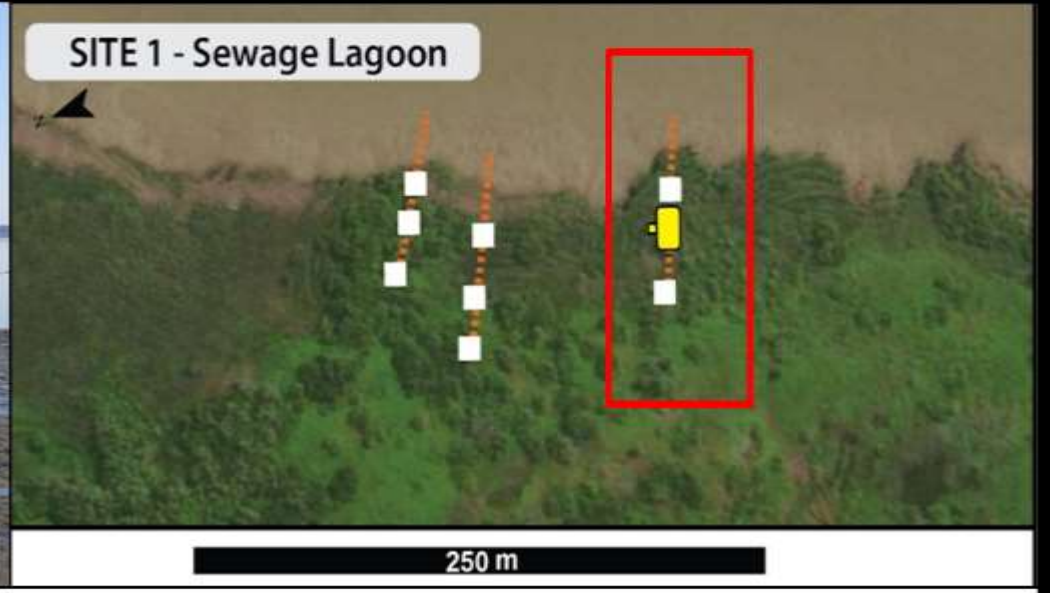
Areas of concern

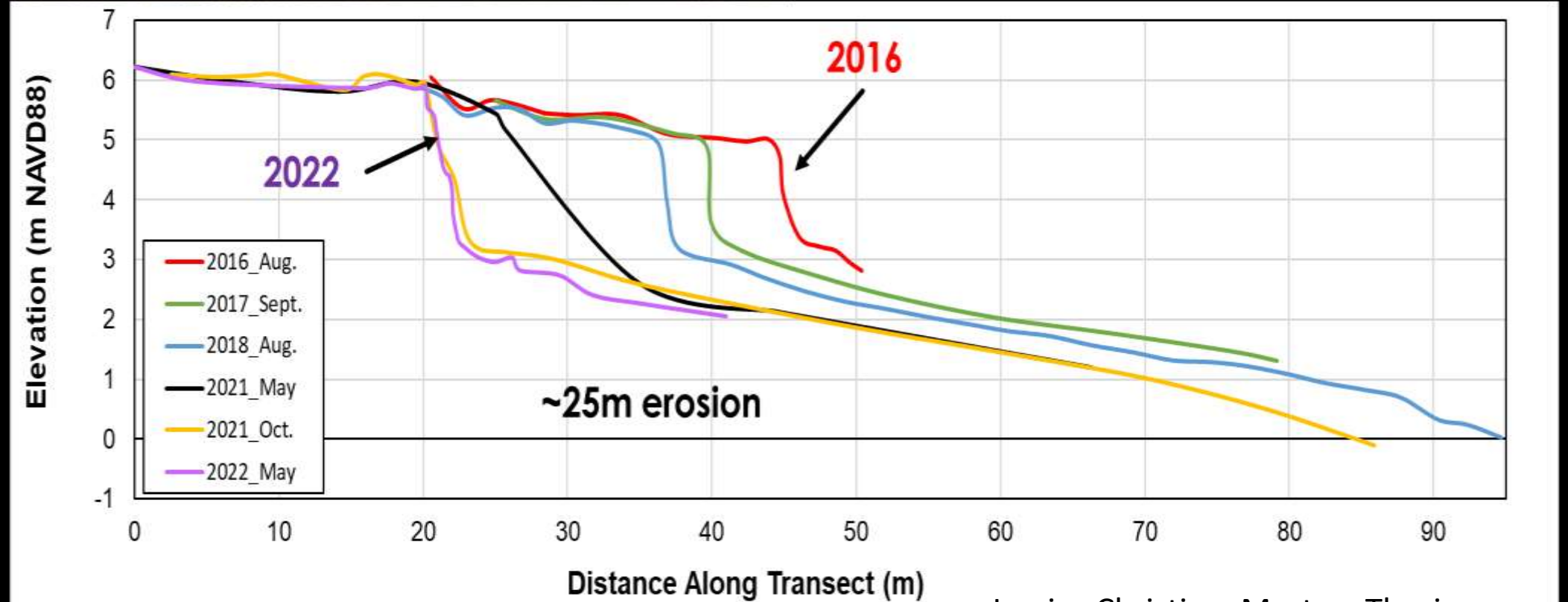
Kanakanak Hospital

City waste treatment facility

Dillingham – Cross-shore profile locations







Jessica Christian, Masters Thesis

Timelapse Videos

Storm at 0:05: August 12th, 2018; maximum wind gust speed 49kts; minimum sea level pressure 992mb

Dillingham

Community Shoreline Analysis

Polaris Project
C. Maio PhD.
M. J. Letzring PhD.
R. Glenn MSc.
Arctic Coastal Geoscience Lab
University of Alaska Fairbanks

1.1 Background

The shorelines of Nushagak Bay have been mapped in maritime charts since the Russian Colonial period. After the Alaska Purchase the United States Coast and Geodetic survey at first copied and translated Russian charts but gradually extended their own surveys to include western Alaska.

The Dillingham Area-of-Study.

1.2 Background

Dillingham and the Nushagak Bay region in maps.

Dillingham and Nushagak Bay, Russian Admiralty 1847, U.S. Coast Survey 1911, NASA U2 overflight 1980.

2.1 Shoreline Time Series

Using the vegetation line is a viable option for shorelines without tidal datum (much of remote Alaska coasts.

Vegetation lines from historic aerial imagery are digitized using GIS tools.

Vegetation line (red) on high resolution medium altitude aerial imagery from 1954 (USGS).

2.2 Shoreline Time Series

In the same GIS project, when a later aerial image is added and vegetation line delineated, the changing shoreline becomes apparent.

This is a 1980s high altitude infrared image. The “false color” of the analog IR photography makes it easy to identify the vegetation line.

1954 vegetation line (red) and 1980 vegetation line (green), showing shoreline change over 26 years (USGS).

2.3 Shoreline Time Series

Beginning in the late 1970s (and slightly earlier for classified military systems) satellites began replacing aircraft for remote-sensing.

The U.S. Landsat system is perhaps the best known, but (until the recent launch of Landsat 9) the best landsat 8 resolution was a 30 meter by 30 meter pixel.

Dillingham Alaska as captured by the sensors in Landsat 8.

2.4 Shoreline Time Series

In the mid 2000s several commercial satellite systems came online with resolution under 5 meters.

Through a research agreement with the NSF, the Polaris Project has access to high resolution RS archives through the Polar Geographic Center at the University of Minnesota.

The RS capture of Dillingham Alaska on the right is from the World View 2 system made in September 2020 with a pixel resolution of under 2 meters.

Dillingham Alaska by World View 2, September 1, 2020.

2.5 Shoreline Time Series

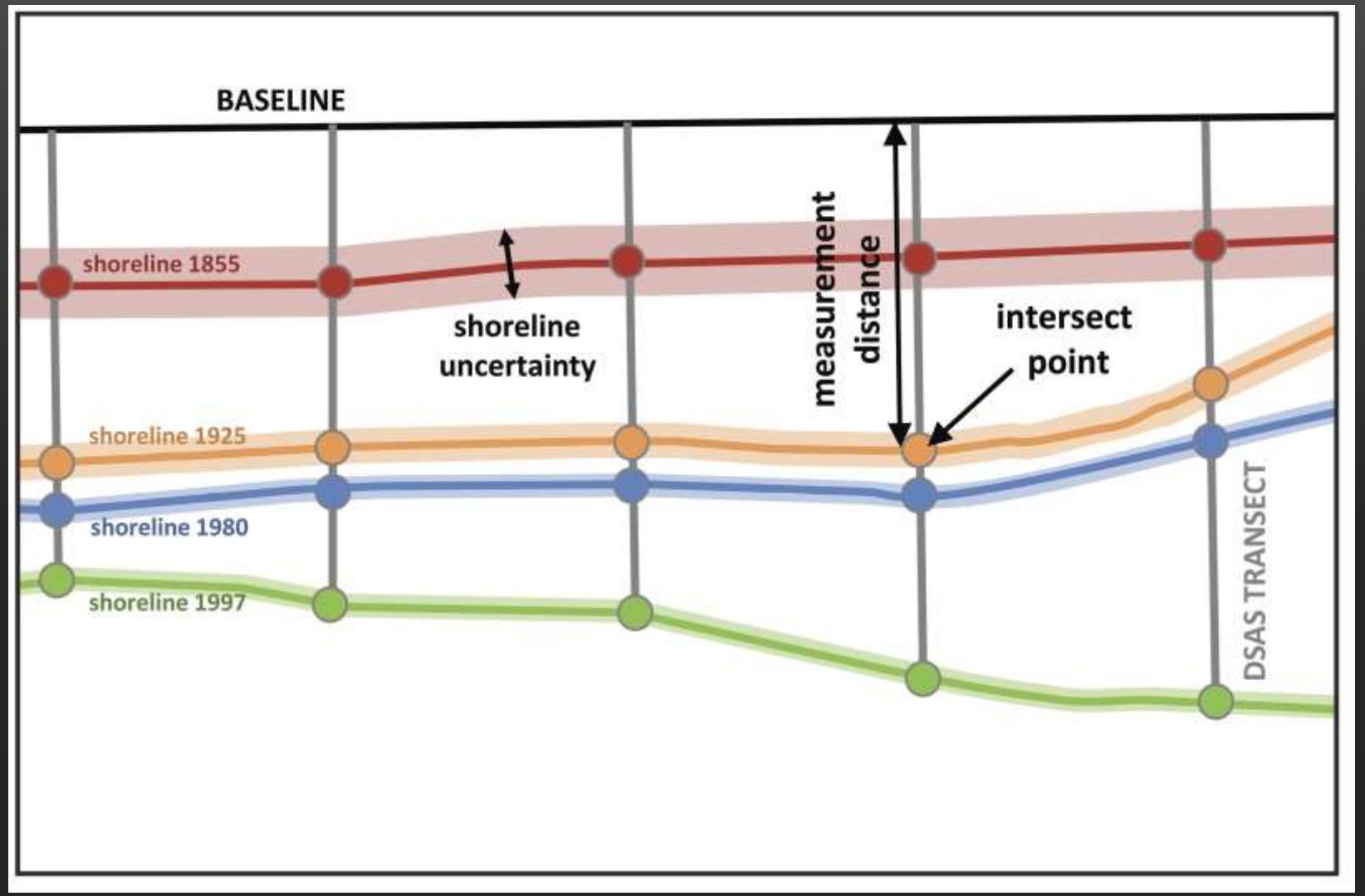
high-resolution remote-sensing imagery from 1980 to 2022 was acquired for use by the Polaris Project.

Shorelines were delineated from the remote sensing data and when visualized give a dramatic illustration of coastal erosion for the Dillingham area.

Dillingham Alaska shorelines, 1980, 2001, 2006, 2011, 2016, 2020.

3.1 Digital Shoreline Analysis

The transects will serve as sample points where they intersect with the time series of shorelines. The data from each of those intersections can be analyzed with different statistical toolsets to identify erosion or accretion trends.

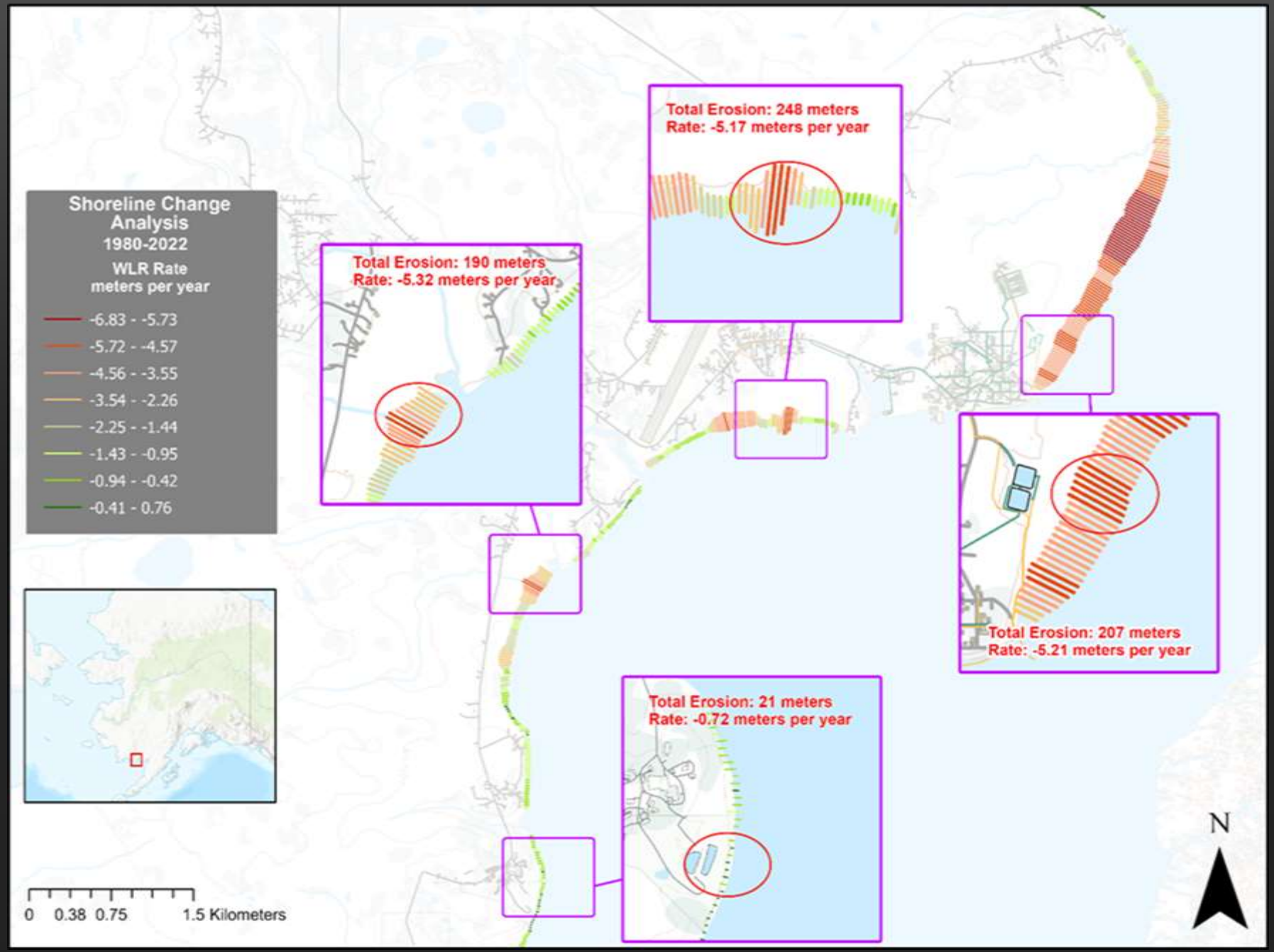


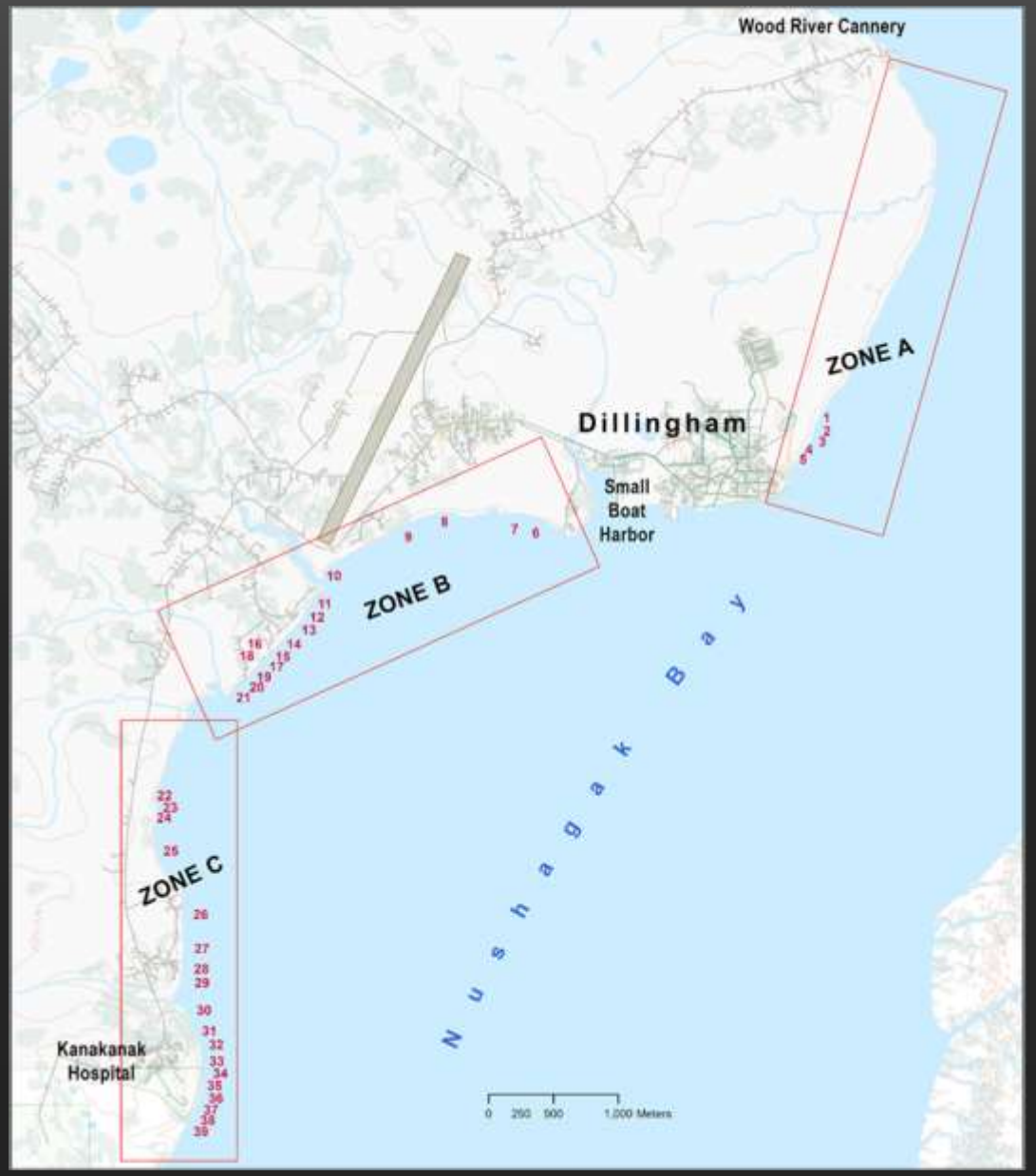
DSAS transect and shoreline intersection example.

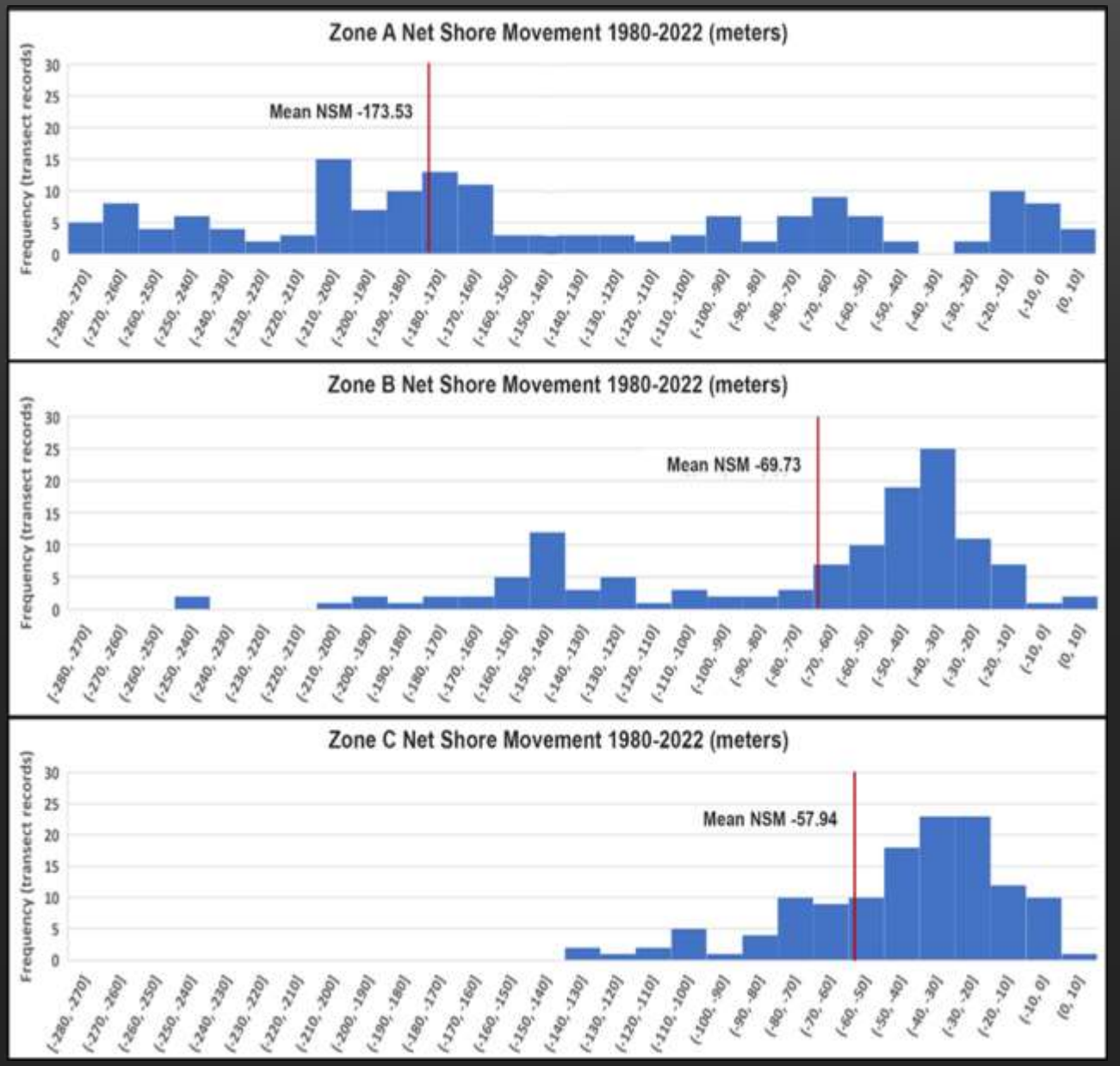
3.2 Digital Shoreline Analysis

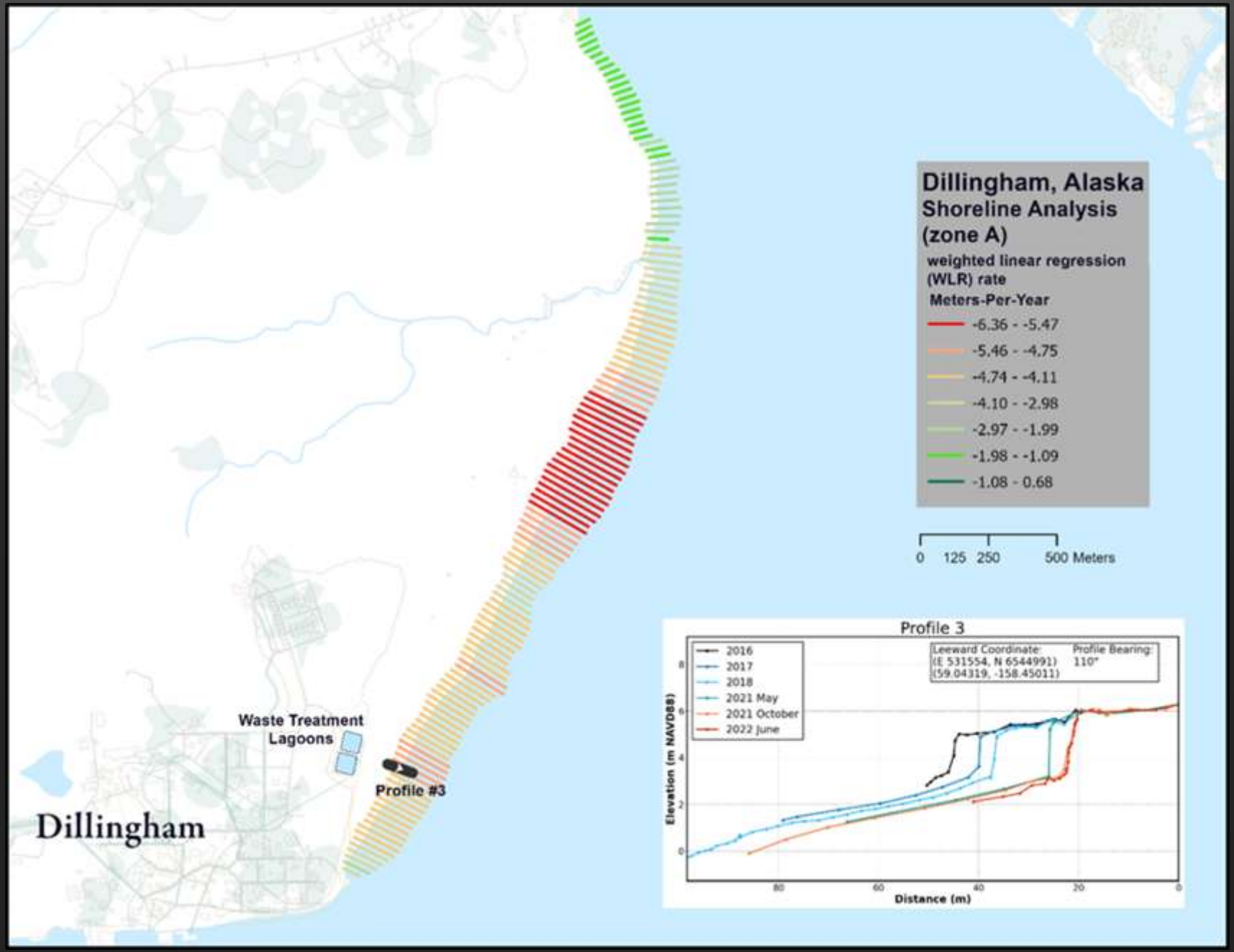
Using the USGS developed Digital Shoreline Analysis System (DSAS) the historic shorelines can be used to identify different rates of shoreline change and project future change.

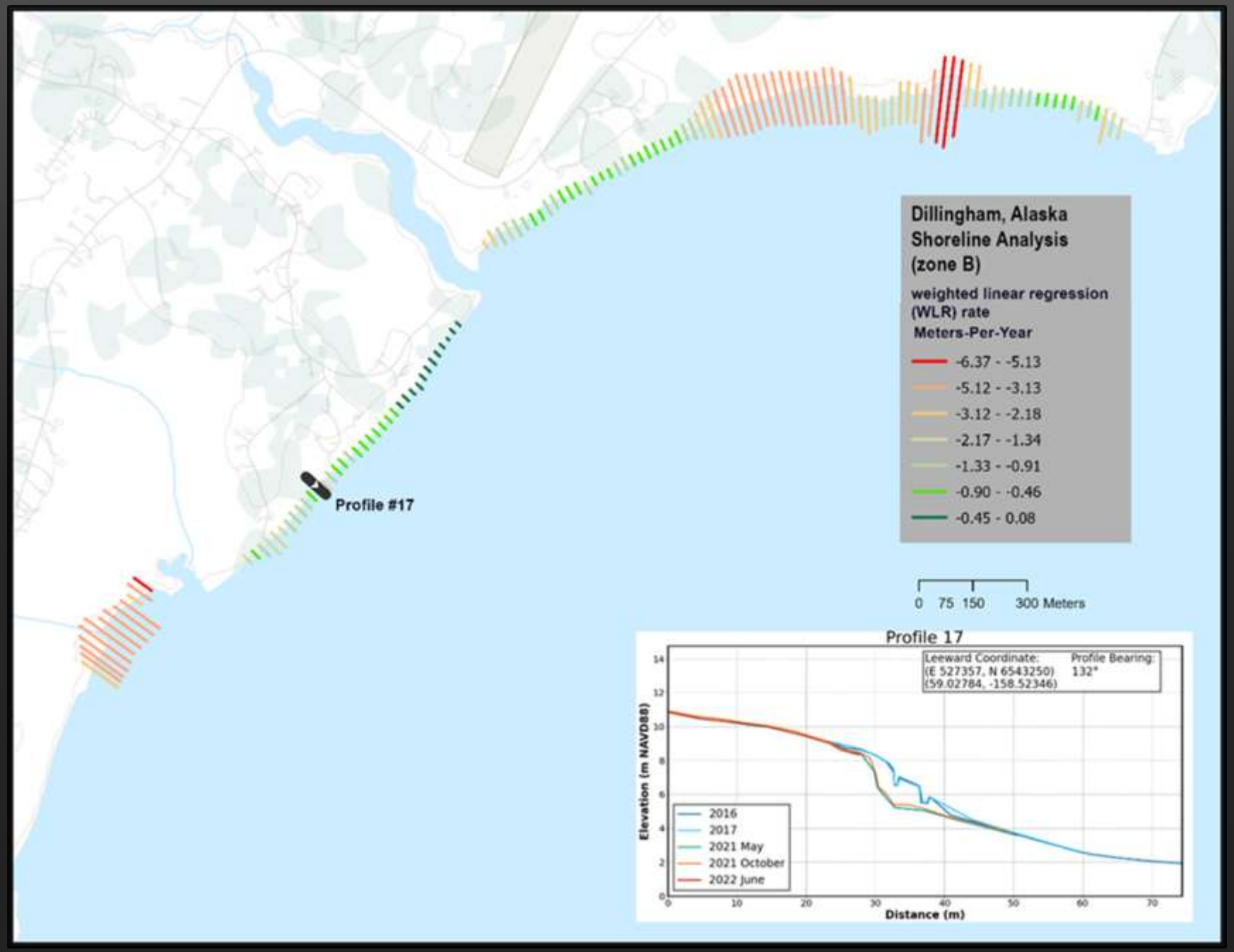
Initial transects in a DSAS analysis, 2020 shoreline in red, 1954 shoreline in green.

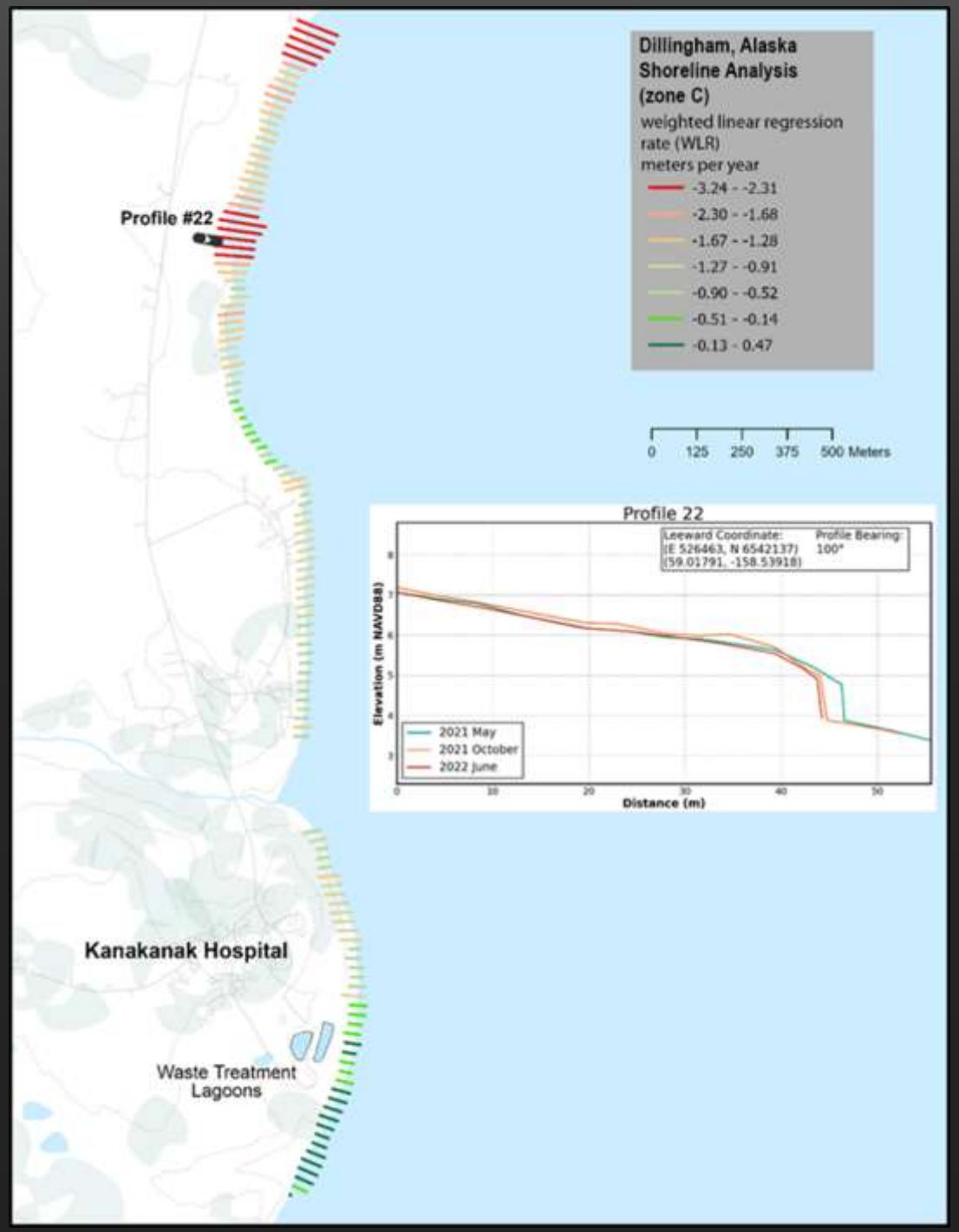

Shoreline Change Analysis
1980-2022
WLR Rate
meters per year
-6.83 - -5.73
-5.72 - -4.57
-4.56 - -3.55
-3.54 - -2.26
-2.25 - -1.44
-1.43 - -0.95
-0.94 - -0.42
-0.41 - 0.76
Total Erosion: 248 meters
Rate: -5.17 meters per year
Total Erosion: 190 meters
Rate: -5.32 meters per year
Total Erosion: 207 meters
Rate: -5.21 meters per year
Total Erosion: 21 meters
Rate: -0.72 meters per year
0 0.38 0.75 1.5 Kilometers
N

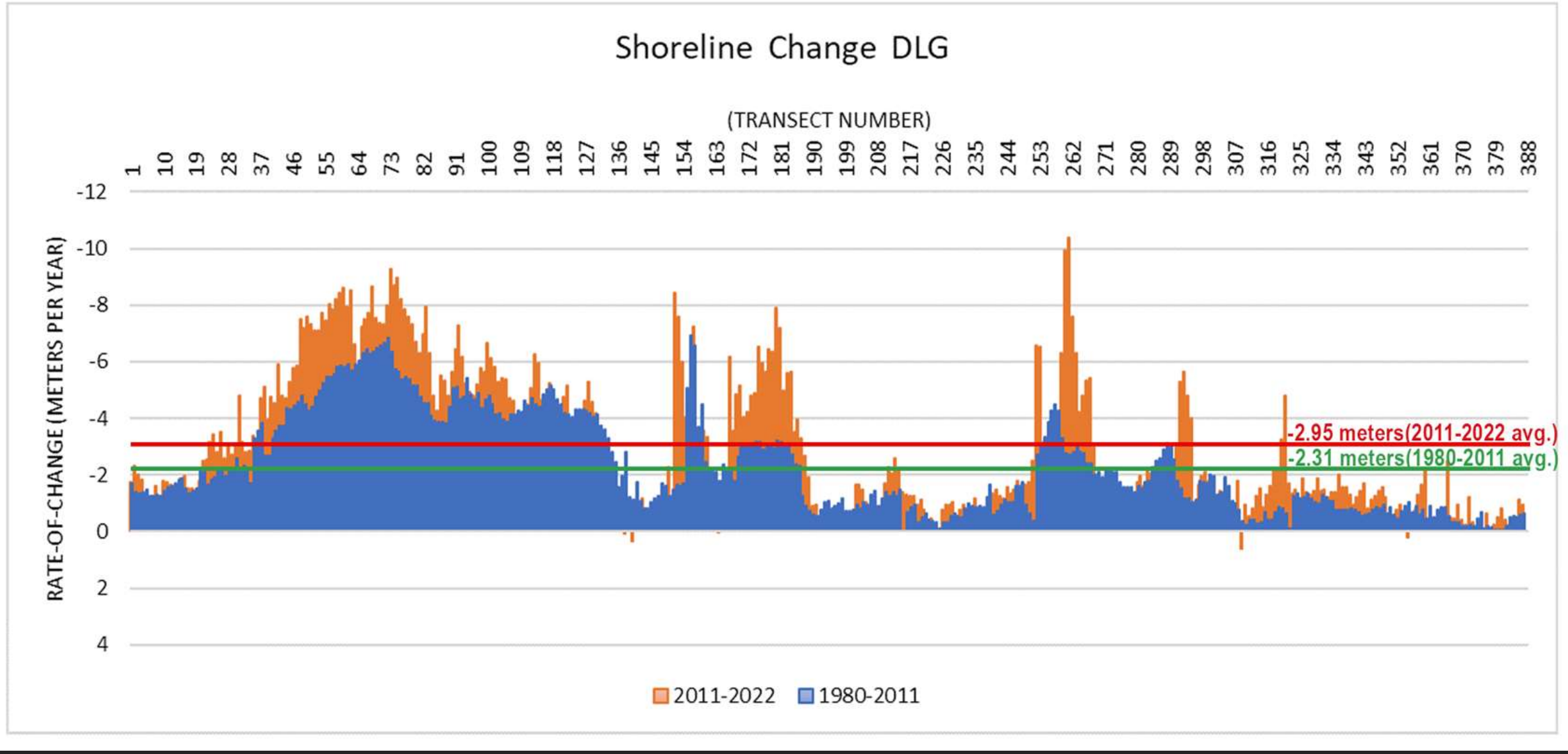

Wood River Cannery
ZONE A
Dillingham
Small
Boat
Harbor
ZONE B
N u s h a g a k B a y
ZONE C
Kanakanak
Hospital
0 250 500 1,000 Meters

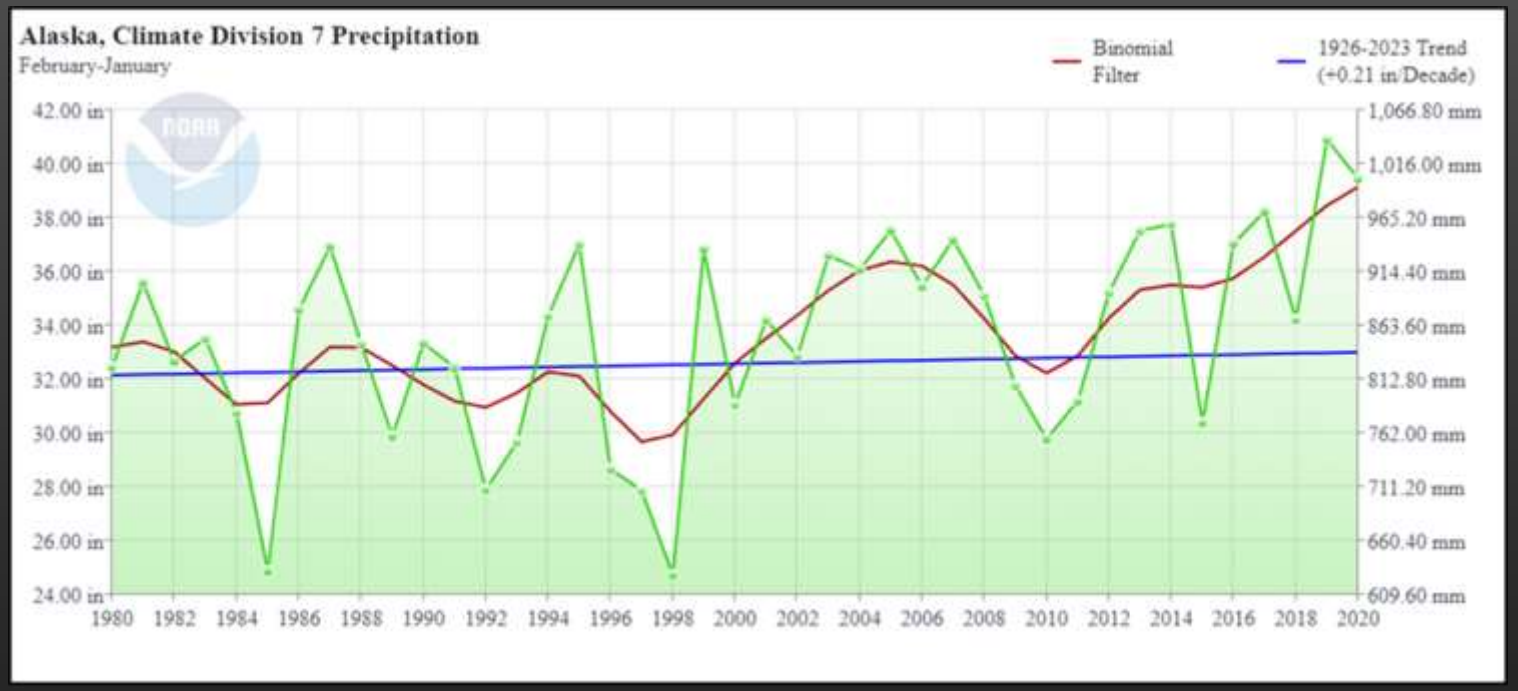

Zone A Net Shore Movement 1980-2022 (meters)
Mean NSM -173.53
Zone B Net Shore Movement 1980-2022 (meters)
Mean NSM -69.73
Zone C Net Shore Movement 1980-2022 (meters)
Mean NSM -57.94
Frequency (transect records)

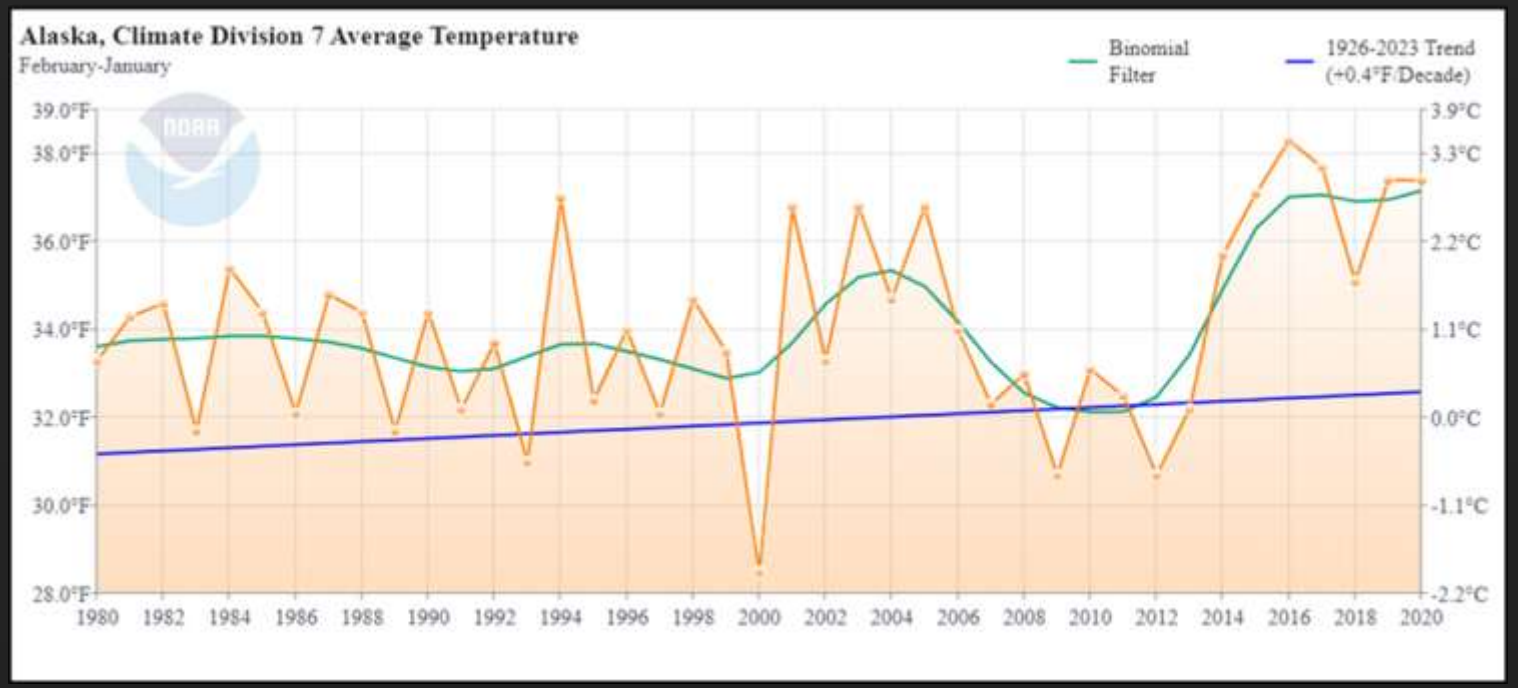





Dillingham, Alaska
Shoreline Analysis
(zone C)
weighted linear regression
rate (WLR)
meters per year
-3.24 - -2.31
-2.30 - -1.68
-1.67 - -1.28
-1.27 - -0.91
-0.90 - -0.52
-0.51 - -0.14
-0.13 - 0.47
0 125 250 375 500 Meters
Profile #22
Profile 22
Leeward Coordinate:
(E 526463, N 6542137)
(59.01791, -158.53918)
Profile Bearing:
100°
Elevation (m NAVD88)
Distance (m)
2021 May
2021 October
2022 June
Kanakanak Hospital
Waste Treatment
Lagoons


Shoreline Change DLG
(TRANSECT NUMBER)
1
10
19
28
37
46
55
64
73
82
91
100
109
118
127
136
145
154
163
172
181
190
199
208
217
226
235
244
253
262
271
280
289
298
307
316
325
334
343
352
361
370
379
388
RATE-OF-CHANGE (METERS PER YEAR)
-12
-10
-8
-6
-4
-2
0
2
4
-2.95 meters(2011-2022 avg.)
-2.31 meters(1980-2011 avg.)
2011-2022
1980-2011





UNIVERSITY OF ALASKA FAIRBANKS

Dillingham Sewage Treatment Facility - Erosion Analysis

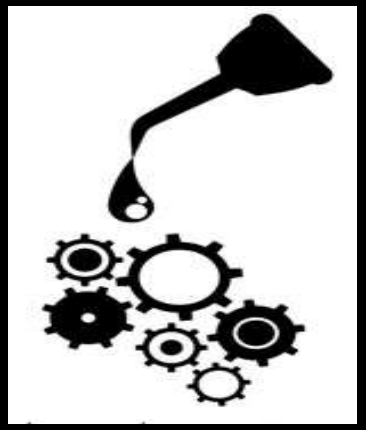
What’s next for coastal hazards in Bristol Bay?

Observations from the field

- **Understanding coastal hazards and their interaction between natural and human systems requires the integration of local and Indigenous knowledge and Western science and technology**
- **Coastal hazards are highly variable but at most locations are increasing**
- **We are in a unique position to observe and measure these rapid changes**
- **Solutions are complicated requiring new innovations and approaches**
- **Our generation has responsibility to document changes and apply research to benefit society**

Alaska Coastal Cooperative

Grease the wheels of collaboration



- **Enhance communication** and synergy between multiple stakeholder groups to address shared goals
- **Advance Applied Science** that addresses local community priorities
- **Enhance workforce development** and education opportunities

NSF

New "ACTION" project funded at $14 million

PAUL G. ALLEN FAMILY FOUNDATION

$590k Awarded for Chigniks Resiliency project

Thanks!

Questions and Comments Please